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The U. S. Coast and Geodetic Survey Magnetic Observatory at Los Angeles, California.

BY PROFESSOR R. E. HALTER.

Assistant U. S. Coast and Geodetic Survey.

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TRADITION tells us the magnetic needle was known to the Chinese as early as the year 2,600 B. C., and from well authenticated information we learn that they had magnetic carriages, on which the moveable arm of the figure of a man continually pointed to the south, as a guide by which to find their way across the boundless plains of Tartary; that was in the obscure age of Codrus, more than a thousand years before the christian era.

About the year 300 A. D., Chinese vessels navigated the Indian ocean under the direction of magnetic needles, and about 800 years later the mariner's compass was used in European waters.

The time of the first knowledge of the declination or variation of the needles by Europeans is very obscure, but the variation is found on a chart of 1436.

Christopher Columbus, on his first voyage across the ocean, discovered a line of no variation, and by his discovery gave a new impetus to the study of terrestrial magnetism. Its vital importance to the mariner and also to the surveyor, was more fully recognized, and gradually better instruments were devised for magnetic observations, and different governments interested themselves in developing a matter of such general interest.

In connection with our survey the first public attention was given to the subject by F. R. Hassler, the first superintendent of the survey in 1825. But the work was only fairly begun by A. D. Bache the next Superintendent in 1843, in making observations for declination, dip, and intensity, with improved instruments, and they have been prosecuted uninterruptedly by the survey up to the present time.

In May, 1882, J. S. Lawson, Assistant U. S. Coast and Geodetic Survey, was instructed by the superintendent to select a site for a permanent magnetic observatory near the coast of Southern California. After carefully investigating several sites in San Diego and vicinity, and also in the vicinity of this city, the present site was selected as combining the greatest number of advantages. Its freedom from local disturbing influences, its secluded position, a good water supply, and its being in a city where nearly all the supplies required could be obtained, recommended it further.

Permission to occupy the Normal School grounds for the purpose in view, was obtained from Gov. Geo. E. Perkins of California, representing the

Board of Trustees of the State Normal School as its president ex-officio, and the building was erected and the latitude and longitude of its site determined by assistant A. F. Rodgers; the latitude being $34^{\circ} 3' 10''$ N., and the longitude $118^{\circ} 14' 40''$ W. from Greenwich. This was accomplished in July, 1882; the building was then turned over to Mr. Werner Suess, mechanic and magnetic expert, of the survey, who placed the instruments in position and made the principal adjustments. The final adjustments were made with the co-operation of Mr. Marcus Baker, acting assistant of the survey, who then took charge of the observatory; and the continuous photographic record was begun in October of the same year. Mr. Baker continued in charge of the work until August, 1884, when he was relieved by the late Mr. Carlisle Terry, Sub-Assistant Coast and Geodetic Survey, and I succeeded Mr. Terry in February, 1887.

This observatory is supplied with a superior self-recording magnetic apparatus, called the Adie magnetograph. It consists of a unifilar, or declination magnetograph, a bifilar, or horizontal force magnetograph, and a vertical force or dip magnetograph; and they record the movement of the magnets photographically. This class of instruments was mainly devised by Welsh, and made by Adie of London, under the auspices of the British Association for the Advancement of Science; and were first operated at the Kew observatory of the British Association in 1857. Magnetic observatories have been established at many places, as at Toronto, Canada; Bombay, India; Parc St. Maur, near Paris, and successively, under the direction of the U. S. Coast Survey at Key West, Florida; Madison, Wisconsin, and Los Angeles, California. The observatory at Kew is still in active operation. There are also "permanent" magnetic observatories in Austria, Russia, Spain and China; but just at this writing I am unable to say if they use the self-recording apparatus.

This observatory has been particularly well adapted for the observations made, on account of the equable temperature in which it is located. To guard against the changes of temperature as much as possible, the building was made double, really two buildings, one inside the other. There is a space of about three feet between the two, and each building has walls and ceilings eighteen inches thick, packed with adobe soil. These precautions reduced the changes of temperature very materially, even though naturally so small. Taking a single year for illustration, the maximum temperature in the magnet room was 87.8° F., and the minimum, 52.5° ; the greatest change for any one day was 5.2° , and the mean maximum and mean minimum temperature for the year were respectively 74.3° and 72.3° , giving a mean daily change of only 2° . The records obtained by the magnetographs at this observatory are of a differential character. On the 14th, 15th and 16th of every month several sets of absolute measures for the declination, dip and intensity are made at another small observatory in the immediate vicinity, but sufficiently removed from the main building to prevent local influence. These observations are combined with the differential records,

and the results thus obtained furnish the material for the discussion and the investigation of the laws which govern the movements of the magnets.

This discussion and investigation is made mainly by Chas. A. Schott, assistant in charge of the computing division of the survey, who has devoted much time and labor to the subject, both practically and theoretically, and is probably the best magnetic authority in this country. His isogonic, isoclinic and isodynamic maps of the United States, which appear in the coast and geodetic survey yearly reports, from time to time, and the discussions which accompany them, are well worth the examination of any one interested in terrestrial magnetism. Although our "permanent" observatories are comparatively few, the survey has made hundreds of temporary magnetic stations throughout the country, and much information has been gained; and yet terrestrial magnetism remains one of the most intricate and mysterious problems of the age, and the cause of this mysterious agency is entirely unknown. Up to the present time no instruments has been devised for making reliable observations at sea, consequently our charts must depend upon land observations for the magnetic information they contain; but our coast observations, combined with the inland observations, give very clear and close directions for the isogonic curves; and thus the mariner is furnished the practical information needed.

The importance of a knowledge of the declination of the magnetic needle to the general public on shore, is testified to by the number of letters received by the office in Washington, asking for information on the subject. In the early history of our country, all, or nearly all, of the surveys were made with the surveyors' compass, and frequently no record was made of variation of the needle, if indeed any allowance was made. To be able to tell what this variation was in the locality and at the time the survey was made, is one of the results of our observations; and thus many portions of our country have boundary disputes settled, and the people spared much litigation.

The instruments now in use here will probably be moved to San Antonio, Texas, next year, where a similar observatory will be built for their reception. The usual life of a "permanent" observatory in one place is variable, depending on the directors, or governments controlling them. Six or seven years, or about the half of a sun-spot cycle, is the least period it is considered profitable to keep up the observations in any one place. The reason for moving in this instance is to investigate the laws of terrestrial magnetism where our knowledge is less complete than in this state.
